

7. Seabird research at Cape Shirreff, Livingston Island, Antarctica, 1999/2000; submitted by Terence M. Carten, Michael Taft, Wayne Z. Trivelpiece and Rennie S. Holt.

7.1 Objectives: The austral summer of 1999-2000 marked the third season of land-based predator studies conducted by the U.S. AMLR program at the Cape Shirreff field camp, Livingston Island, Antarctica (62° 28'S, 60° 46'W). Cape Shirreff is one of two sites on the Antarctic Peninsula where long-term monitoring of predator populations is being undertaken in support of US participation in CCAMLR (Convention for the Conservation of Antarctic Marine Living Resources). The objectives of the seabird research for the 1999/2000 season were to collect the following predator monitoring data:

1. To estimate chinstrap and gentoo penguin breeding population size (CCAMLR Ecosystem Monitoring Program (CEMP) Standard Method A3);
2. To band 1000 chinstrap and 200 gentoo penguin chicks for future demography studies (CEMP Std.Method A4);
3. To determine chinstrap penguin foraging trip durations during the chick rearing stage of the reproductive cycle (CEMP Std. Method A5);
4. To determine chinstrap and gentoo penguin breeding success (CEMP Std. Methods 6a,b&c);
5. To determine chinstrap and gentoo penguin chick weights at fledging (CEMP Std. Method 7c);
6. To determine chinstrap and gentoo penguin diet composition, meal size, and krill length/frequency distributions via stomach lavage (CEMP Std. Methods 8a,b&c), and
7. To determine chinstrap and gentoo penguin breeding chronologies (CEMP Std. Method 9).

7.2 Accomplishments: Four scientists were put ashore by the expedition cruise ship R/V *Lawrence M. Gould* on the 31 October 1999, and research continued until camp closure on 9 March 2000. Additionally, two more scientists were transferred to Cape Shirreff aboard the R/V *Lawrence M. Gould* on the 22 December 1999, another scientist was brought to the field camp aboard the M/V *Prof. Molchanov* on the 29 January 2000 and the R/V *Yuzhmorgeologiya* brought one scientist to Cape Shirreff on the 21 February 2000. Logistical support and transit back to Punta Arenas, Chile at the end of the season was provided by the R/V *Yuzhmorgeologiya*.

Breeding Biology Studies.

The Cape Shirreff penguin rookery consists of 30 breeding colonies of penguins; 19 chinstrap penguin (*Pygoscelis antarctica*) colonies, six gentoo penguin (*P. papua*) colonies and five colonies with both species. Chinstrap and gentoo penguin breeding populations were censused on 28 and 30 November 1999, approximately one week following the peak of clutch initiation of both species. Only half of the rookery was censused on the 28th, due to inclement weather. The remainder of the breeding pairs was counted on the 30th. All colonies were counted in their entirety according to CEMP Standard Methods. The breeding populations in the 1999/00 season were determined to be 7,744 chinstrap penguin pairs and 922 gentoo penguin pairs. The number of chinstrap penguin breeding pairs was slightly higher than in the 1998/99 season. Gentoo penguins showed an 11% increase in breeding pairs from the 1998/99 season.

Reproductive success was determined by following a sample of 100 banded chinstrap penguin pairs and 50 gentoo penguin pairs from egg laying to crèche formation. Chinstrap penguins hatched 1.26 chicks/pair and fledged 1.02 chicks/pair, with 81% of all hatched chicks surviving to fledging. Gentoo penguins had higher reproductive success hatching 1.72 chicks/ pair and fledging 1.4 chicks/pair, also with 81% of all hatched chicks surviving to fledging. Reproductive success of chinstrap penguins declined in the 1999/00 season, compared to 1998/99, except for the percent of hatched chicks that survived to fledging, which was slightly higher. Gentoo penguin reproductive success was higher in all variables in 1999/00, compared with 1998/99.

Counts of all chicks on 8 February produced a total of 9,226 chinstrap penguin chicks and 1,159 gentoo chicks. This represented an increase of 5% for chinstrap penguins and 14% for gentoo penguins over the chick counts from the 1998/99 season.

We banded a sample of 1,000 chinstrap and 200 gentoo penguin chicks for future demographic studies. Birds that survive and return to the rookery will be followed throughout their reproductive lives during future seasons.

Chinstrap penguin chick fledging weights were collected daily between 16 February and 24 February, according to CEMP Standard Method 7c. The mean fledging weight of 223 chicks captured on the rookery beaches, as they were about to depart to sea, was 3,250g, compared with 3,200g for the 1998/99 season. “Fledging” weights were also collected for gentoo penguin chicks. Gentoo penguin chicks do not fledge in the classic sense, returning after their first trips to sea to be supplementally fed by their parents. Therefore, weights were collected at a set date during the breeding chronology, at 85 days post-mean clutch initiation, for inter-annual comparisons. Assuming a 36-day incubation period, gentoo penguin chicks were approximately 7 weeks old at the time of weighing, the age at which other *Pygoscelis* penguins fledge. Two hundred chicks were captured and weighed on 10 February, with a mean weight of 4,040g, a decrease of 410g from the 1998/99 season.

Foraging Ecology Studies.

Diet studies of chinstrap and gentoo penguins during the chick-rearing phase were initiated on 4 January and continued through 8 February 2000. Forty chinstrap and 20 gentoo penguin adults returning from foraging trips to sea were captured at their nest sites, prior to feeding their chicks, and their stomach contents were removed by lavaging. We noted the sex of the returning adult, the number of chicks present at the nest, and their approximate ages. Krill (*Euphausia superba*) was present as a prey species in 100% of the samples from both species, while evidence of fish was noted in only 3% of chinstrap, but 80% of gentoo penguin samples. The one chinstrap penguin diet sample containing fish evidence consisted of a single otolith. Gentoo penguins frequently had fresh fish in their stomachs, as well as semi-digested squid and octopi. As in the past two seasons, the length frequency distribution of krill in the penguins' diets during 1999/00 was predominated by three CCAMLR size classes, which accounted for 91% of all krill in the samples. The strong 4-5 year age class of krill represented in 1998/99 was predominant again with the majority of krill shifting up into the 41-45, 46-50 and 51-55mm CCAMLR size categories (Figure 7.1).

We attached 18 radio transmitters to adult chinstrap penguins feeding 1-1.5 week old chicks on 2-3 January and followed their foraging trips through mid-February using a remote receiver and data logger set up in the rookery. As in the past two seasons, foraging trips exhibited a bimodal distribution. The main peak for trip duration was around 8 hours, less than in the 1997/98 and 1998/99 seasons. The second peak, near 12 hours, was again shorter than the past two seasons. Trends in the diel pattern of foraging trips (Figure 7.2) were similar in all three years of data, with shorter trips beginning between dawn and noon and longer trips (> 12 hours) including the overnight period. Lack of otolith evidence in the chinstrap diets during 1999/00 may suggest that fish were not as abundant for the nocturnal foragers as in the past two seasons. It seems that in some years, fish may not be as important a component in the adult chinstrap diet as we have previously suggested. However, an inshore survey, conducted in early February, found large krill aggregations just off Cape Shirreff; the existence of abundant krill inshore may have altered the usual chinstrap penguin foraging patterns and caused adults to subsist almost entirely on krill in 1999/00.

Time-depth recorders (TDRs) were deployed three times during the season to study diving behavior. Five TDRs were placed on chinstrap penguins and five on gentoo penguins in early January. A second deployment (5 chinstrap, 5 gentoo) occurred in mid-January. All TDRs remained on for 7-10 days of foraging before being removed and downloaded. A third deployment of five TDRs was put on chinstrap penguins in early February to coincide with a nearshore hydroacoustic survey off Cape Shirreff. All instruments remained on the penguins throughout the five-day survey.

In addition to the radio transmitters and time-depth recorders, PTTs (satellite-linked transmitters) were deployed on chinstrap penguins during the chick-rearing phase to determine foraging locations. Five PTTs were deployed in early January. The instruments remained on for 7-10 days before being retrieved for another deployment in mid/late January. One penguin failed to return from the second deployment leaving us with four instruments. A third and final round was put out to coincide with the nearshore hydroacoustic survey. These remaining PTTs stayed on for the entire five-day survey as well. Analyses of penguin foraging locations and dive records are currently being processed.

Reproductive studies of brown skuas (*Catharacta lonnbergi*) were conducted throughout the field season. All skua chicks and any new breeding adults were banded. Measurements of culmen length and depth, tarsus length, and weight were collected for all newly banded skuas. Reproductive performance of kelp gulls (*Larus dominicanus*) was followed opportunistically throughout the season.

7.3 Preliminary Conclusions: The third (and for some parameters, fourth) season of data collection at Cape Shirreff has allowed us to compare annual indices of population size, foraging behavior, and reproductive performance among years. Overall reproductive success of chinstrap penguins was lower in the 1999/00 season than in 1998/99 and slightly lower than the three year mean. Gentoo penguin reproductive success was higher in 1999/00 compared with 1998/99, and was also above the three-year mean. The mean fledging weight of chinstrap penguin chicks for the 1999/00 season was slightly higher than in 1998/99, and comparable to the four-year mean (fledging weights were also collected during the 1996/97 season). Mean fledging weights for gentoo penguin chicks were lower in 1999/00 than in 1998/99, and below the three-year mean. The number of chinstrap and gentoo penguin breeding pairs was higher in 1999/00 than in the previous season, as were the numbers compared to the three-year mean. Future research plans include continuing the annual CCAMLR predator monitoring protocols and at-sea foraging behavior studies with time-depth recorders (TDRs) and satellite-linked transmitters (PTTs). These methods, in addition to the annual marine survey, will enable us to investigate the seasonal and inter-annual variability of the land-based predator indices at Cape Shirreff and to compare this variability to data from the adjacent marine ecosystem, collected by the AMLR marine surveys.

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